Penile Anatomy

Blood supply

Common iliac artery bifurcates at SIJ

After short distance internal iliac artery divides into anterior and posterior divisions

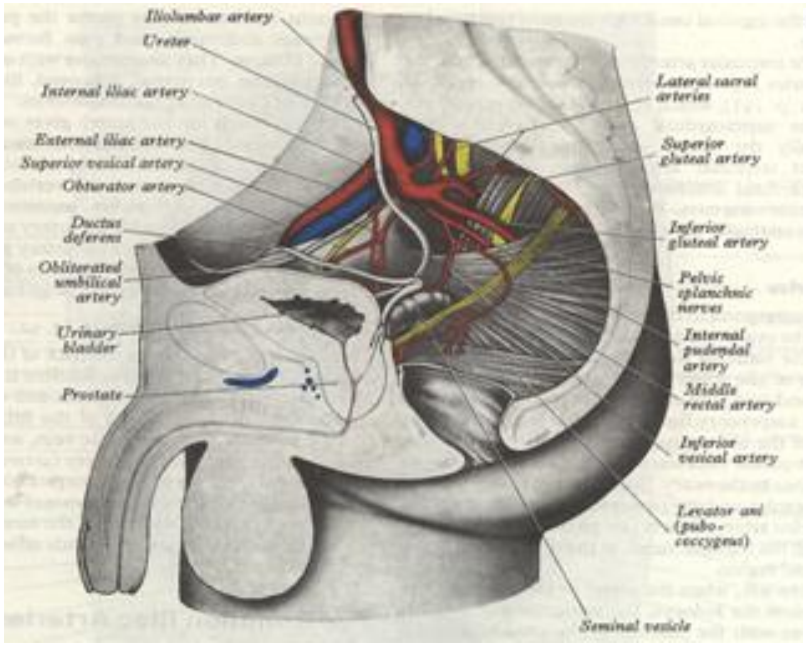
Posterior division (3)

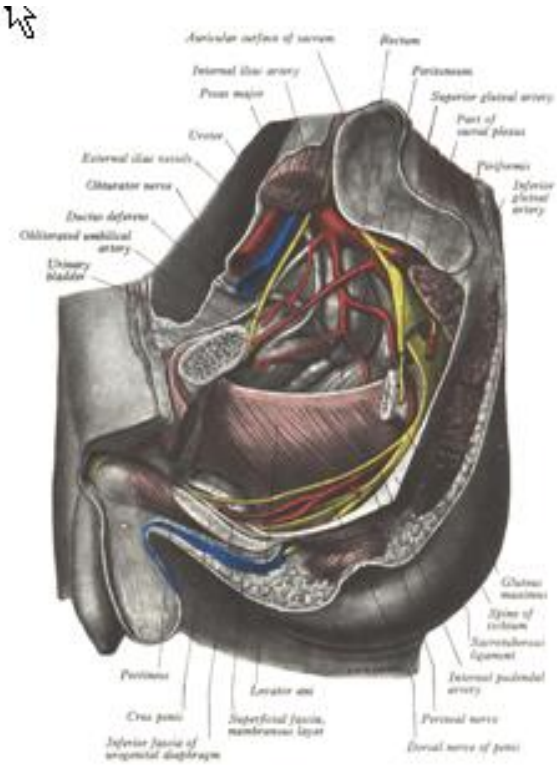
- Iliolumbar
- Lateral sacral
- Superior gluteal

Anterior division (9; 3 bladder, 3 other viscera; 3 parietal)

- Superior vesical
- Obliterated umbilical
- Inferior vesical
- Middle rectal
- Vaginal
- Uterine
- Obturator
- Inferior gluteal
- Internal pudendal

In the male there are no named uterine and vaginal arteries. Rather the seminal vesicles, ductus deferens and prostate are supplied by branches of the inferior vesical artery

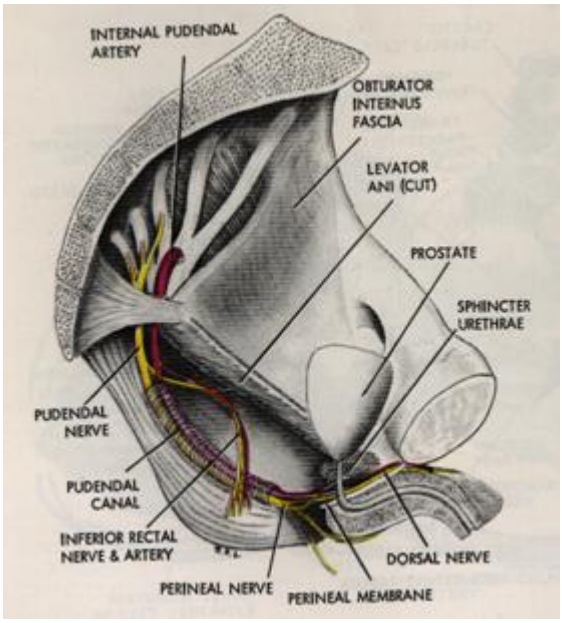




Internal pudendal artery

Passes out of the pelvis below piriformis through greater sciatic foramen

Runs in Alcock's canal within ischiorectal fossa then turns into lesser sciatic foramen and runs on surface of obturator internus which is closely applied to ischial tuberosity. Gives off inferior rectal branch and runs forward piercing deep perineal space.



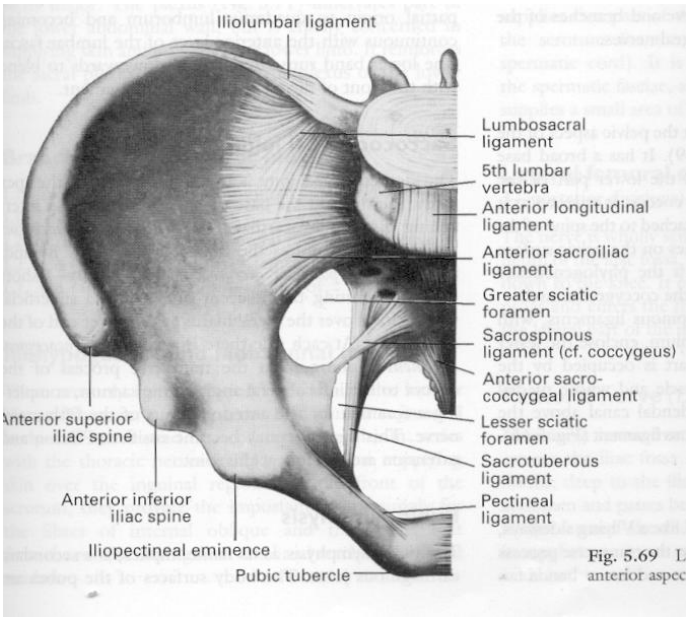
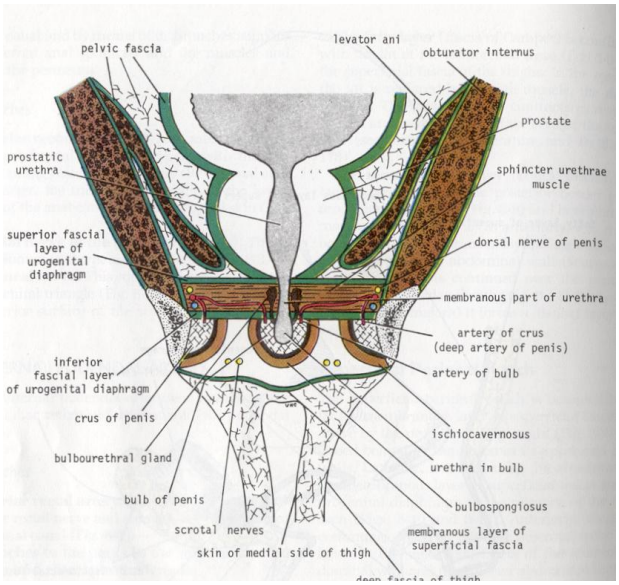
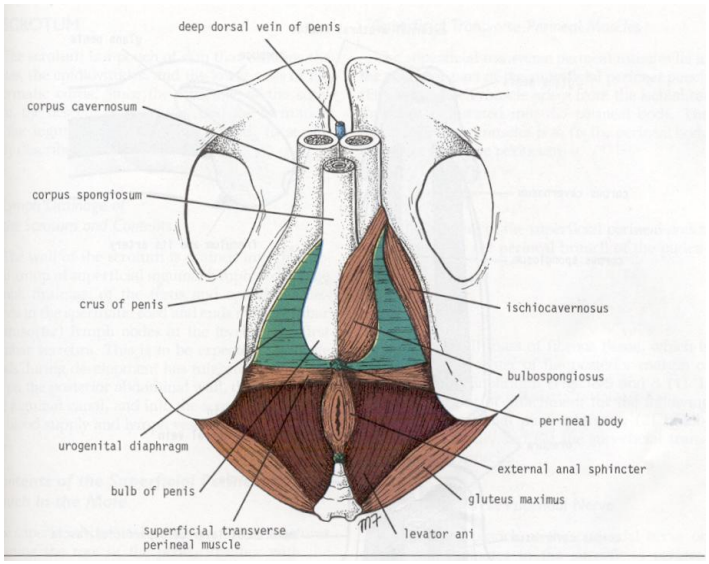


Fig. 5.69 L
anterior aspec

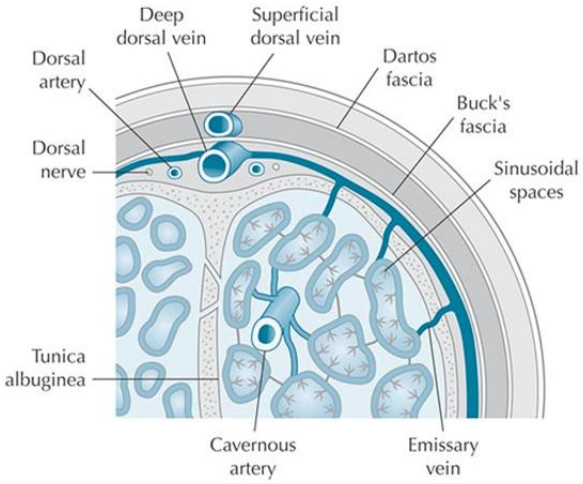


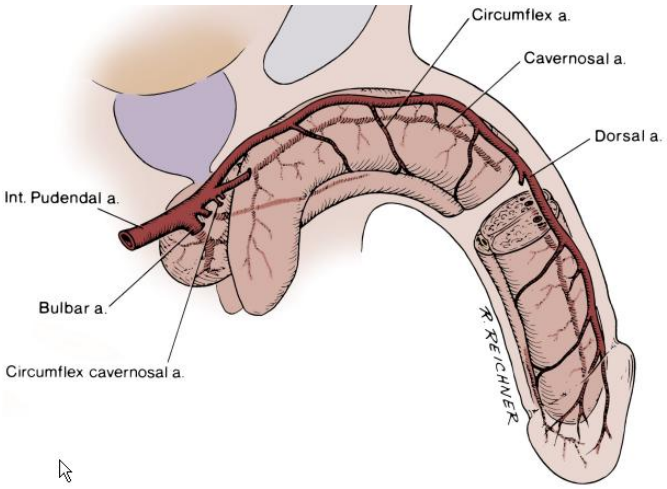


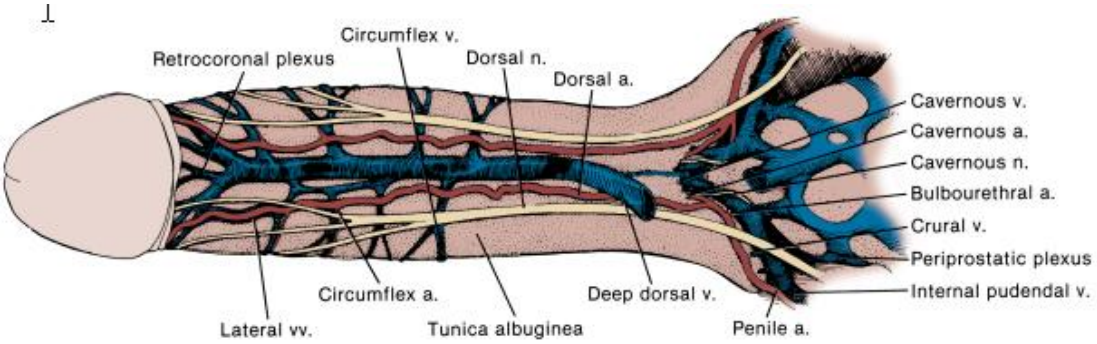
Branches of internal pudendal artery:

- Inferior rectal
- Posterior scrotal
- Transverse perineal
- 3 penile arteries:
  - (i) Bulbar — Runs medially in deep perineal space to supply corpus spongiosus (above right) and urethra. Anastomoses with dorsal penile around glans (urethra has antegrade AND retrograde blood supply)
  - (ii) Cavernosal — Runs forward into crus of penis to supply corpus cavernosum. End artery – no anastomosis
  - (iii) Dorsal penile — Runs on top of crus towards midline, pierces suspensory ligament and joins

median deep dorsal vein and dorsal penile nerves (see below – artery should be red). Runs forward to supply skin, fascia and glans.







<u>Pudendal nerve</u>
Anterior roots of S2/3/4
Runs in pudendal canal with pudendal artery
Divides *within pudendal canal* to give terminal branches, dorsal nerve of penis (direct continuation; see above right) and larger perineal branch

(i) Dorsal nerve	runs lateral to dorsal artery as above Supplies penile skin and glans and branches to c. cavernosum. No branches in deep perineal pouch Nerves become indistinct towards distal half penis.
(ii) Perineal branch	Superficial and deep transverse perineal muscles Urethral sphincter (rhabdosphincter - Onuf's) Ischiocavernosus Bulbocavernosus Penile urethra sensation posterior scrotal branches

Skin innervation of penis and scrotum

Penis	dorsal penile branch of pudendal (S2) posterior scrotal from perineal branch of pudendal small area on dorsum of penile shaft (L1)
Scrotum	Anterior 1/3 ilioinguinal nerve and genital branch of genitofemoral nerve (L1)

Posterior 2/3 perineal branch perineal nerve (S3)

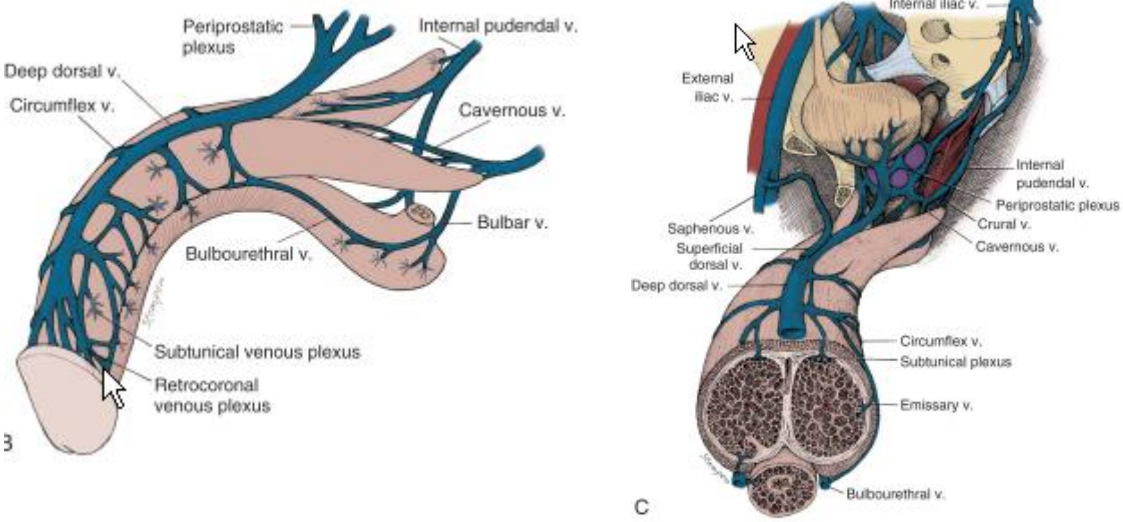
Erectogenic pelvic nerves

Intermediolateral horn cells of S2/3/4

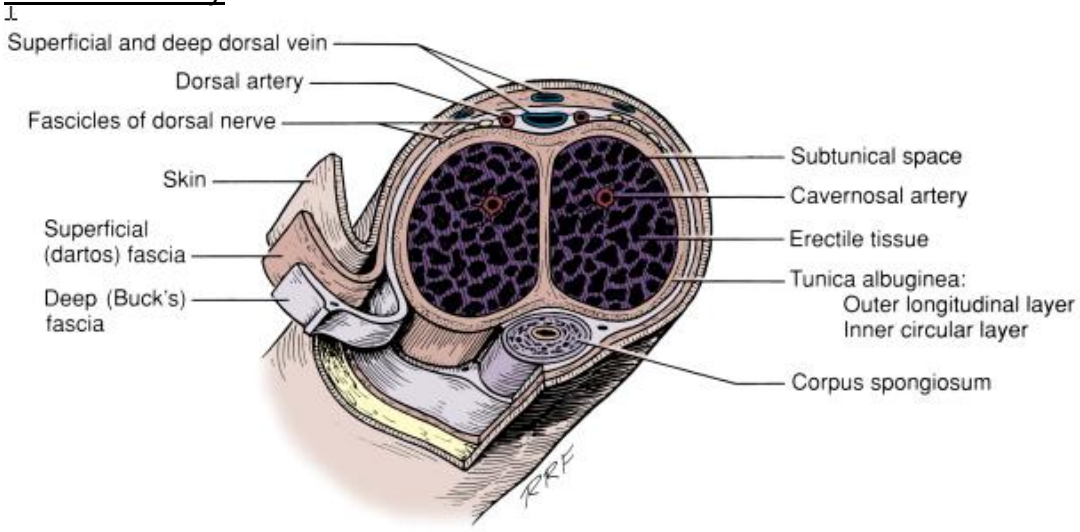
Run in pelvic splancnic pelvic nerves to inferior hypogastric plexus (also known as pelvic plexus; located in saggital plane on either side of rectum)

Cavernosal nerves travel from tip of seminal vesicles along posterolateral border of prostate to apex of prostate (5 o'clock and 7 o'clock). Pierce perineal membrane, give slips to sphincter at 3 o'clock and 9 o'clock positions, and rotate dorsally above cavernous vein to enter corpora at 1 o clock and 11 o'clock positions respectively

Venous drainage



Penile anatomy



Bucks fascia fuses with tunica albuginea proximally. Therefore rupture of tunica albuginea contained within Buck's fascia – aubergine deformity

Dartos fascia in continuity with Scarpa's fascia. Therefore rupture of tunica abuginea and Buck's fascia leads to Butterfly deformity. If unRx associated urethral injury urine can spread to limits of Scarpa's fascia – namely collar bones, mid-axillary lines and limit of fusion with fascia lata [NB. Dartos fascia also known as Colles' fascia]

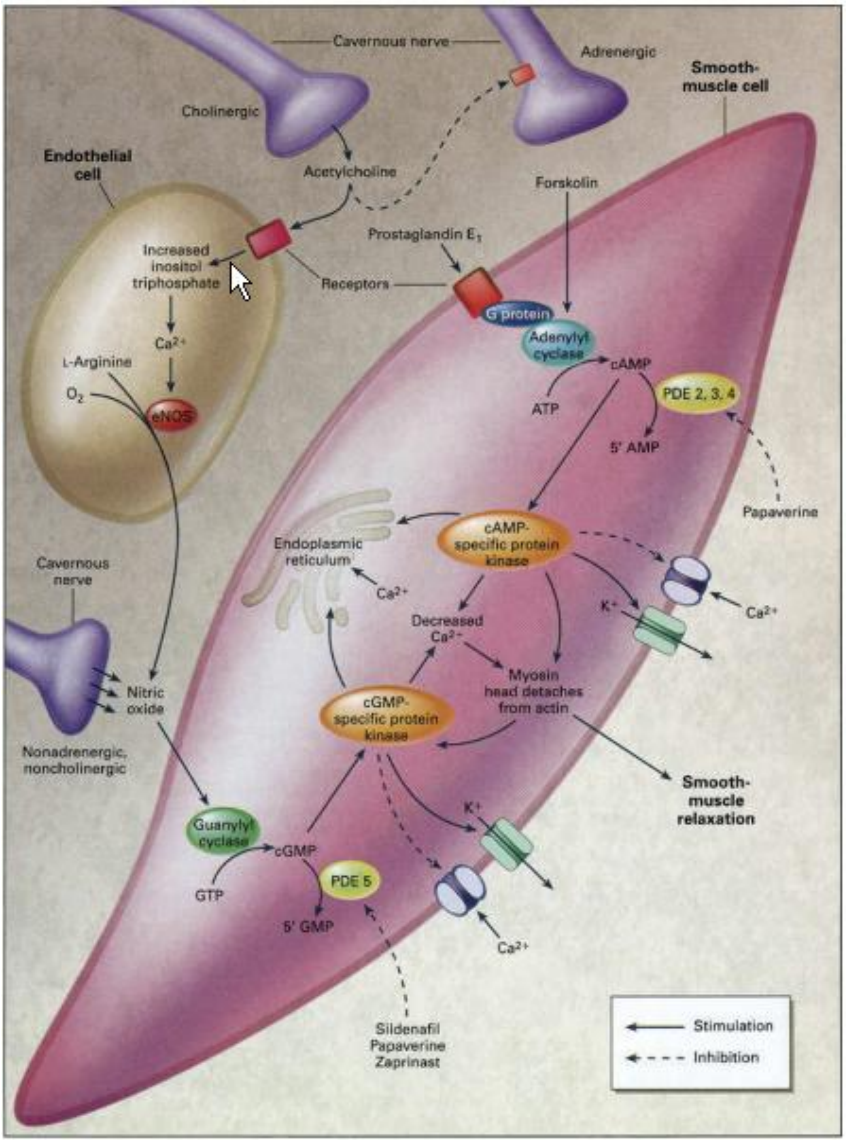
Physiology of erection and ejaculation

Erection

Higher centres include amygdala, hippocampus, visual and sensory cortex
Central processing in hypothalamus - medial preoptic area (MPOA) and paraventricular nucleus (PVN)
Descending pathways via dorsolateral funiculus to intermediolateral horn cells of spinal grey matter (parasympathetic) and lateral corticospinal (somatic)
Sacral parasympathetic and somatic motor from S2/3/4
Pelvic splancnic nerves to inferior hypogastric plexus; pudendal nerve to ischiocavernosus and bulbocavernosus
Cavernous nerves alongside prostate, slips to rhabdosphincter and ramification in corpora cavernosa
2 types of cavernous nerves; cholinergic and NANC (release of NO)
Erection overview

> Parasympathetic activation – raised cGMP and cAMP – reduced intracellular calcium – sinusoidal smooth muscle relaxation – arterial inflow – erection

Mechanisms



Central neurotransmitters

Dopamine	excitatory	apomorphine (D1 and D2 stim.)
Serotonin	generally inhibitory	
GABA	inhibitory	
Oxytocin	excitatory	
NO	excitatory	
Prolactin	inhibitory	

Nitic oxide synthase

3 types: nNOS (nerve), eNOS (endothelium), and iNOS (non-specific – all cells)

All types of NOS catalyse formation of NO and L-citrulline from L-arginine and oxygen

Nitric oxide released from the terminals of cavernous nerves diffuses across smooth muscle membrane and stimulates guanylate cyclase to produce cGMP from GTP. Most important mechanism. Re-inforced by eNOS stimulated production of more nitric oxide

Cyclic GMP stimulated production of protein kinase G which opens potassium channels and closes calcium channels

Degradation of cGMP by phosphodiesterase limits effect

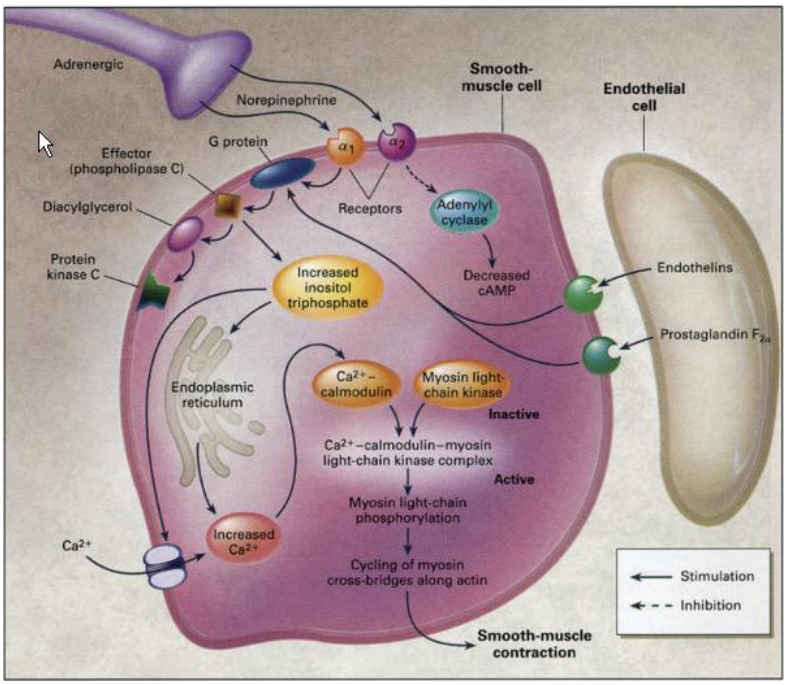
Reduced circulating calcium leads to dissociation of calcium from calmodulin from MLCK, inactivating it. Inactive MLCK leads to dissociation of myosin heads from actin, leading to relaxation.

Adenylate cyclase-cAMP pathway alternative non-neurogenic mechanism for driving down intracellular calcium concentrations. Activated by PGE1 but not PGI2 or PGF2 (remember **F**lacc**I**d)

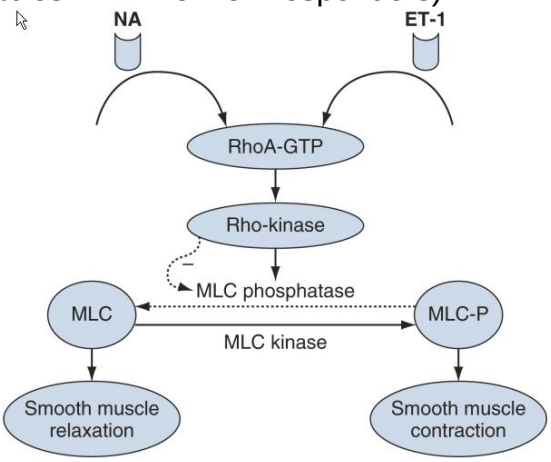
Other erectogenic peptides include VIP, histamine and substance P

Reinforcement of erection by contraction of ischiocavernosus and bulbocavernosus under somatic motor involuntary control via Onuf's nucleus

<u>Detumescence</u>



Detumescence under sympathetic control
Same higher centres; sympathetic outflow T10-L2
Synapse in sympathetic chain; hypogastric nerves to inferior hypogastric plexus; travel with cavernous nerves to supply penis
Sympathetic adrenergic nerve terminals release NA which acts via mainly alpha 1 (A and D receptors) to inhibit adenylate cyclase and activate second messengers which raise intracellular inositol triphosphate.
Raised IP3 leads to Ca release from sarcoplasmic reticulum and opening of calcium channels. Ca-calmodulin activates MLCK and subsequent phosphorylation of mysin leads to smooth muscle contraction*.
Endothelin, PGI2 and PGF2 TXA2 also promote flaccidity via IP3 pathway
* recently Rho-kinase identified – inhibitor of myosin phosphorylation under NA and ET control (see below). Oral inhibitors of Rho-kinase being developed (may replace injectables in PDE5i non-responders)



<u>Haemodynamics of erection</u>

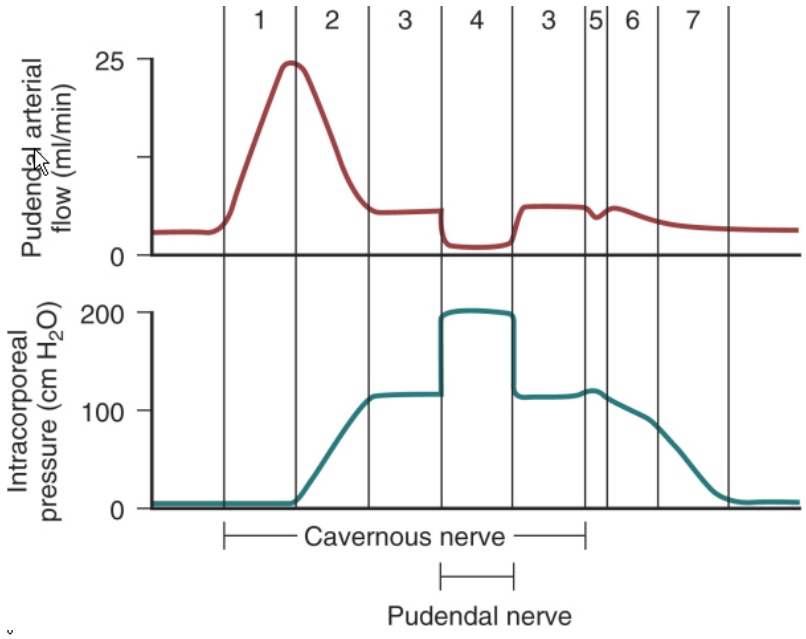


Figure 21-6 Blood flow and intracavernous pressure changes during the seven phases of penile erection and detumescence: **0,** flaccid; **1,** latent; **2,** tumescence; **3,** full erection; **4,** rigid erection; **5,** initial detumescence; **6,** slow detumescence; **7,** fast detumescence.

NB. Note re-inforcement of erection by ischiocavernosus and bulbocavernosus (pudendal nerve S2/3/4). Remember compression of

subtunical venules in subtunical space by engorged sinusoids – therefore reduced flow in emissary veins

Ejaculation

Higher centres as for erection
MPOA and PVN generally stimulate ejaculation
Nucleus paragigantocellularis **inhibitory**
Main neurotransmitters dopamine and serotonin
Serotonin
- Central serotonin inhibitory ($5HT_{2C}$)
- Peripheral ($5\text{-}HT_{1A}$ receptor) excitatory

At some stage, sensory input from penis (dorsal nerve of penis) > descending inhibition from nPGi, leading to ejaculation
Sympathetically controlled (T10-L2)
2 distinct phases co-ordinated centrally; emission and expulsion
- Emission
  - Peristatic contraction of epididymis, vas, seminal vesicles propels sperm and seminal fluid into prostatic urethra
  - Bladder neck contraction
- Expulsion (? Onuf's nucleus mediated)
  - Rhabdosphincter relaxation
  - Rhythmic contraction of bulbospongiosus

Premature ejaculation

Concept of intravaginal ejaculatory latency time (IVELT)
International Society for Sexual Medicine defines PME as IVELT < 1 min, essentially arbitrarily defined
Causes:
- Psychogenic — New onset, new partner etc.
- Organic — Penile hypersensitivity
  - Serotonin receptor abnormality
    - $5HT_{2C}$ receptor hyposensitivity
    - $5\text{-}HT_{1A}$ receptor hypersensitivity

Management
- Behavioural therapy
  - Stop-squeeze technique
  - Stop-pause technique
  - Long-term results poor (<50% success), esp. in those patients with lifelong PE
- Pharmacology
  - Topical local anaesthetics
    - 80% effective but satisfaction low and vaginal hypoaesthesia (condom)
  - SSRIs
    - 70-80% effective
    - Paroxetine best but cannot be stopped abruptly
    - Sertraline a/w mental dysfunction
    - Fluoxetine safest 5-20mg/day
    - Dapoxetine new agent with short half-life (1.5 hrs) – give 30-60mg prn 1-2 hours before anticipated intercourse.

SE = nausea, diarrhoea sweating

PDE5is

May have a role in induction of vasal smooth muscle tone and muscle relaxation